

REMARKS

Review and reconsideration on the merits are requested.

Formalities

Applicants appreciate the Examiner:

Approving the drawings;

Acknowledging receipt of the one priority document; and

Returning two initialed MODIFIED PTO/SB/08 forms.

The Prior Art

JP Pub. No. 2002-240215 (“Koichi”); U.S. Pat. 6,468,698 (“Hamano”); U.S. Pub. 2004/0202928 (“Miyamoto”); U.S. Pub. No. 2003/0108797 (“Iijima”).

Applicants now turn to the rejections and discuss the rejections following the paragraphing of the Examiner.

The rejections are all respectfully traversed.

Unless necessary to an understanding of Applicants’ position, the Examiner’s interpretation of the prior art and application of the claims to the prior art will not be discussed.

Paragraph 2

Claims 1-5 were rejected as anticipated by Koichi.

Discussion of the Claims

Applicants would like to discuss important features in claim 1 and in claim 6. The specification of the present application makes it clear that the microporous composite membrane of claim 1 can only be produced by following the method of claim 6.

Claim 1

With respect to claim 1 to the microporous composite membrane, three important requirements are added:

- (1) the microporous composite membrane is provided with excellent adhesion to electrodes without deteriorating permeability;
- (2) the fluororesin is a hexafluoropropylene-vinylidene fluoride copolymer; and
- (3) the cylindrical penetrating pores are fine pores penetrating substantially perpendicularly from openings to a surface in contact with the microporous polyolefin membrane while keeping circular cross sections of substantially the same diameters, and have a larger average diameter than the maximum pore diameter of the microporous polyolefin membrane.

Requirement (1) is supported by Paragraph [0059] of the specification, requirement (2) is supported by Paragraph [0062] and Examples 1-6, and requirement (3) is supported by Paragraphs [0059] and [0060].

Claim 6

With respect to claim 6 (newly added in place of the canceled method claim 3), five important requirements are present:

- (1) the gelable fluororesin is a hexafluoropropylene-vinylidene fluoride copolymer;
- (2) the poor solvent has a higher boiling point than that of the good solvent;
- (3) the resultant porous coating layer has a thickness of 0.4 μm to 1.0 μm ;
- (4) the good solvent is evaporated earlier than the poor solvent; and
- (5) the porous coating layer has cylindrical penetrating pores, which are fine pores penetrating substantially perpendicularly from openings to a surface in contact with the microporous polyolefin membrane while keeping circular cross sections of substantially the

same diameters, and have a larger average diameter than the maximum pore diameter of the microporous polyolefin membrane.

As earlier discussed, the requirement (1) is supported by Paragraph [0062], etc.

Requirements (2) and (4) are supported by Paragraph [0070].

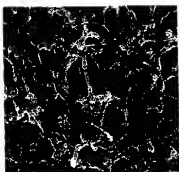
Requirement (3) is supported by the data of Examples 1-6 in Table 1.

Requirement (5) is the same as described in amended claim 1.

Discussion of Koichi

Koichi discloses a composite membrane comprising a porous coating layer of a gelable functional polymer formed on at least one surface of a microporous polyolefin membrane. Among various polymers described in Koichi as preferable ones, polyvinylidene fluoride is the closest to the fluororesin recited in claim 1. The Examiner mentions that "polyvinylidene fluoride (porous coating layer) has a porous structure with a rod like edge having an opening (cylindrical penetrating pores)." However, Fig. 1 of Koichi shows that the porous coating layer of Koichi has irregularly shaped pores, which are totally different from the cylindrical penetrating pores of the present invention. Because Fig. 1 was not included in the English translation attached to the Office Action, it is set out below.

Fig. 1



In distinction to Koichi, the cylindrical penetrating pores of the present invention are fine pores penetrating substantially perpendicularly from openings to a surface in contact with the microporous polyolefin membrane while keeping circular cross sections of substantially the same diameters. This is clear from Fig. 1 attached to the specification of the present application.

The reason why cylindrical penetrating pores are formed in the present invention is that the gelable fluororesin used is a hexafluoropropylene-vinylidene fluoride copolymer, the gelable fluororesin is dissolved in a mixed solvent of a good solvent and a poor solvent having a higher boiling point than that of the good solvent, and drying is conducted such that the good solvent is evaporated earlier than the poor solvent to form a porous coating layer of the fluororesin having cylindrical penetrating pores. These requirements are recited in new claim 6.

Good solvents for polyvinylidene fluoride used in Koichi are cyclohexanone (boiling point: 155.7°C), γ -butyrolactone (boiling point: 203°C), ethylene carbonate (boiling point: 246°C), dimethyl acetamide (boiling point: 165°C), N-methylpyrrolidone (boiling point: 202°C), and dimethyl sulfoxide (boiling point: 189°C), etc., and poor solvents are benzene (boiling point: 80.1°C), methyl isobutyl ketone (boiling point: 116.2°C), dimethylformamide (boiling point: 153°C), ethanol (boiling point: 78.3°C).

In Examples 1-4, N-methylpyrrolidone is used as the good solvent, and ethanol is used as the poor solvent. It is clear from the above lists that the good solvents have higher boiling points than those of the poor solvents. Because of this combination of a good solvent and a poor solvent, the poor solvent is evaporated earlier than the good solvent from the coating layer of Koichi, which is formed from a solution of the functional polymer (polyvinylidene fluoride) in a mixed solvent of the good solvent and the poor solvent. As a result, irregularly shaped pores are formed in the coating layer of Koichi.

To form cylindrical penetrating pores, the use of a mixed solvent of a good solvent and a poor solvent having a higher boiling point than that of the good solvent for a hexafluoropropylene-vinylidene fluoride copolymer is not by itself sufficient to yield the results desired in accordance with the present invention, rather, a porous coating layer formed from a solution of a hexafluoropropylene-vinylidene fluoride copolymer in the mixed solvent is thin, i.e., as 0.4-1.0 μm . The reason for this will be explained referring to Figs. A and B attached hereto.

Fig. A schematically shows a cross section of the porous coating layer in Example 1 of the present application. Because the porous coating layer is 1.0 μm thick with pores having an average diameter of 2 μm , each pore is formed by a poor-solvent phase, which goes into each pore. Because the average diameter of each pore is much larger than the thickness of the porous coating layer, pores penetrate substantially perpendicularly from openings to a surface in contact with the microporous polyolefin membrane while keeping circular cross sections of substantially the same diameters.

Fig. B shows a cross section of a thick porous coating layer in which poor-solvent phases having much smaller diameters than the thickness of the porous coating layer are dispersed. Small pores are connected to penetrate the porous coating layer, so that the penetrating pores inevitably will not have cylindrical shapes with substantially the same cross sections.

Having such cylindrical penetrating pores means that the porous coating layer is sufficiently thin as compared with the average diameter of pores. Accordingly, the thickness of the porous coating layer is not recited in claim 1.

It is clear from the above discussion that the microporous composite membrane of claim 1 having defined the cylindrical penetrating pores is totally different from the composite membrane of Koichi.

Paragraphs 3 and 4

These paragraphs are treated together in view of the emphasis on the discussion of claim 6.

In Paragraph 3, claims 1-5 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Hamano in view of Miyamoto and in Paragraph 4, claim 3 was rejected under the same section over Hamano and Miyamoto as applied to claims 1-2 and 4-5 and further in view of Iijima.

The discussion will, however, apply with equal force to claim 1 and claim 6. Applicants rely upon their arguments for claim 1 for the patentability of claims 2, 4 and 5.

Iijima

Iijima discloses a method for producing a porous film comprising polymer particles (for instance, polyvinylidene fluoride particles) and a polymer binder (for instance, a vinylidene fluoride-hexafluoropropylene copolymer binder).

As the Examiner points out (though the Examiner uses somewhat different language), Iijima discloses in Paragraph [0046]. "the aforesaid solvent in which the polymer particles are insoluble and the polymer binder is soluble is used as a first solvent and a second solvent in which both the polymer particles and the polymer binder are insoluble is added to the first solvent. In such a solvent mixture, the second solvent should preferably have a boiling point higher than that of the first solvent. When such a boiling point difference relation is satisfied, the evaporation of the first solvent is followed by the evaporation of the second solvent."

It is noted that in the porous film of Iijima, solvent-insoluble particles are an indispensable component and are added at a high proportion. Paragraph [0061] of Iijima discloses that the weight ratio of the polymer particles to the polymer binder is 70:30 to 98:2.

Although the Examples of Iijima yield single-layer porous films comprising polymer particles and a polymer binder, Iijima describes in Paragraph [0051]:

“When a porous resin film is used as the carrier film, however, this carrier film may be used without being released off. A porous resin film to which a polymer film capable of gelling is deposited, too, may be used as the porous film in the invention. For the porous resin film used herein, for instance, use may be made of a polyolefin film used as a separator in ordinary lithium secondary batteries.”

Iijima further discloses in Paragraph [00651]

“[I]t is acceptable to use a polymer particle-free porous film as in the prior art. *** Preferably in this case, a plasticizer, for instance, dibutyl phthalate (DEP) is incorporated in the polymer particle-free porous film as mentioned above, thereby forming pores in the porous film.”

Taking into consideration the disclosures in Iijima in the above paragraphs, it might be reasonable to conclude that Iijima suggests a polymer particle-free porous film formed on a porous polyolefin film. Even if Iijima could reasonably be construed as containing such a teaching, nonetheless Iijima fails to teach that the porous coating layer should have cylindrical penetrating pores, which are fine pores penetrating substantially perpendicularly from openings to a surface in contact with the microporous polyolefin membrane while keeping circular cross sections of substantially the same diameters, and having a larger average diameter than the maximum pore diameter of the microporous polyolefin membrane.

As discussed above, to form such cylindrical penetrating pores, the use of a mixed solvent of a good solvent and a poor solvent having a higher boiling point than that of the good solvent for a hexafluoropropylene-vinylidene fluoride copolymer is not enough, rather, further there must be used a porous coating layer formed from a solution of a hexafluoropropylene-vinylidene fluoride copolymer in the mixed solvent should be as thin as 0.4-1.0 μm .

Because Iijima simply suggests the formation of a polymer particle-free porous film on a porous polyolefin film, it is logical to conclude that the polymer particle-free porous film is as thick as those described in the specification of Iijima. The specification of Iijima describes in Paragraph [00491] that the porous film is as thick as 5-100 μm . Accordingly, the polymer particle-free porous film formed on a porous polyolefin film must be as thick as 5-100 μm , and therefore cylindrical penetrating pores cannot be formed as the thickness limit of 0.4-1.0 μm of claim 6 is not met by such a film.

Accordingly, it is logical to conclude that the method of Iijima is totally different from the method of claim 6, not suggesting the important features of claim 6.

Hamano and Miyamoto

Miyamoto discloses a secondary battery comprising positive and negative electrodes each having an insulating polyvinylidene fluoride layer, and a separator which may be made of polypropylene. Because the insulating polyvinylidene fluoride layers come into contact with the polypropylene separator, it is assumed that the Examiner considered that Miyamoto substantially describes the layer structure of the microporous composite membrane of the present invention.

However, even if the structure described in Miyamoto is same as the layer structure of the present invention comprising a microporous polyolefin membrane and a porous coating layer, the insulating polyvinylidene fluoride layer of Miyamoto is totally different from the porous

hexafluoropropylene-vinylidene fluoride copolymer coating layer of the present invention. Polyvinylidene fluoride cannot be dissolved in a mixed solvent of a good solvent and a poor solvent having a higher boiling point than that of the good solvent. Accordingly, cylindrical penetrating pores cannot be formed when polyvinylidene fluoride is used.

Hamano discloses a separator having an adhesive resin layer comprising polyvinylidene fluoride and an ionically-conducting polymer. However, Hamano does not use a mixed solvent of a good solvent and a poor solvent for polyvinylidene fluoride.

Since Hamano discloses a separator having an adhesive resin layer of polyvinylidene fluoride, a combination of Hamano with Miyamoto would provide a porous composite membrane comprising a porous polyolefin membrane and a polyvinylidene fluoride coating layer, which is totally different from the microporous composite membrane of the present invention.

The specification of the present application states in Paragraph [0014] that the fluororesin is preferably polyvinylidene fluoride and/or a vinylidene fluoride copolymer. This description has been found erroneous. Accordingly, it is amended to "the fluororesins is preferably a vinylidene fluoride copolymer.

Hamano and Iijima

With respect to Hamano and Iijima, in the Office Action at page 6, it is stated:

"[I]t would have been obvious to one having ordinary skill in the art to combine the prior art references by substituting the mixed solvent described by Iijima for the NMP solvent used by Hamano for the benefit of increasing the amount of the liquid electrolyte to be retained because Iijima teaches that use of these components as solvent provides higher porosity."

However, because Iijima does not teach the important features of claim 6 that the porous coating layer should be as thin as 0.4-1.0 μm to have cylindrical penetrating pores, even a combination of Hamano and Iijima would not suggest the method of claim 6.

As discussed above in detail, the cited reference fail to teach the important features of the present invention, which are recited in claims 1 and 6. Accordingly, the microporous composite membrane recited in claim 1 and its production method recited in claim 6 are patentable thereover.

Withdrawal of all art rejections and allowance is requested.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,



Peter D. Olexy
Registration No. 24,513

SUGHRUE MION, PLLC
Telephone: (202) 293-7060
Facsimile: (202) 293-7860

WASHINGTON OFFICE

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CUSTOMER NUMBER

Date: October 13, 2009

Fig. A

A schematic diagram of a block copolymer structure. It consists of a horizontal bar with alternating shaded and unshaded rectangular blocks. The total width of the bar is labeled as $2\ \mu\text{m}$. The height of the bar is labeled as $1.0\ \mu\text{m}$. Labels 'Good-solvent phase' and 'Poor-solvent phase' point to the unshaded and shaded blocks, respectively.

Fig. B

